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EXPERIMENTAL MUSICAL INSTRUMENTS

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF NEW SOUND SOURCES

TAPES WILL BE MADE

Many thanks to all who wrote or called in with feedback on the question of whether we should produce cassette tapes of instruments featured in the pages of EMI. Some disadvantages to the idea have been pointed out (see the Letters section in this issue), but the overall response has been highly favorable, and we've decided to give it a whirl. Work is underway on a cassette presenting most of the instruments from EMI's first year and a half of publication. Judging by what we've got so far, the tape looks to be gloriously diverse: challenging, amusing and beautiful by turns.

The EMI cassette will be completed and available by the start of December. Subscribers will have the option of purchasing the tape at a lower price than the general public. Complete details will appear in EMI's December issue.

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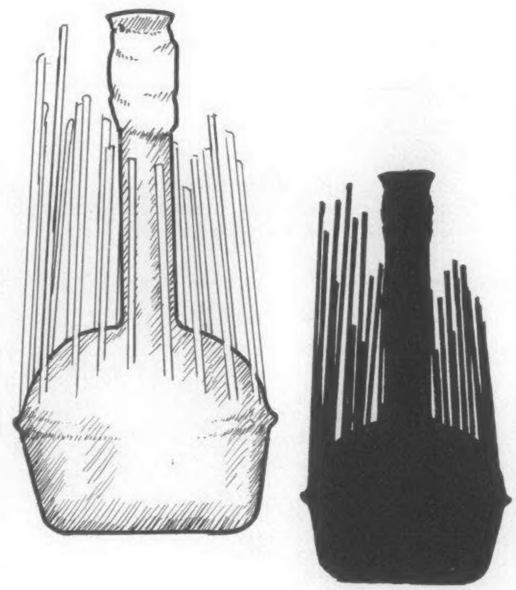

Above right: The Waterphone. The article on this extraordinary instrument begins below right.

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THE WATERPHONE
Invented and built by Richard Waters
Patent #38966966

By any of several measures, the Waterphone is one of the most successful of new acoustic instruments. It has been taken up and played by many musicians, composed for by many composers, and heard by vast audiences -- though most in those audiences may not have been aware of what they heard. It has been used widely in recordings, performances, and movie and TV scores. It has sold commercially in respectable quantities. But the primary consideration for any new instrument must be its sound -- and the sound of the Waterphone is incomparable.

SOME BACKGROUND AND HISTORY

The inventor and builder of the Waterphone is Richard Waters of Sebastopol, California. One day

(continued on page 6)

LETTERS

I have some thoughts on the subject of producing tapes to go along with the magazine. Some readers feel that including tapes would be an essential part of the magazine's purpose, however, I feel that this may be counterproductive.

If I read about an instrument and then play a tape of it, I will make a judgment based on whether or not I like the sound I hear. If I like the sound then I can build the instrument and it will sound like the tape. If I don't like the sound then I just won't build it. Either way, nothing is gained.

On the other hand, now I read about an instrument, and I imagine what it sounds like. If the sound I imagine is something I want to hear, then I can build an instrument like the one I read about. This opens up many possibilities for experimentation and learning. If it turns out that I imagined the wrong sound, then I can experiment to learn more about the way the instrument works and how I can manipulate it to produce the sounds I want, or why it can't be manipulated to produce the sounds I want.

This is a magazine about experimentation, not imitation. After working with some of the basic materials of musical instruments it becomes easy to get a good idea in your head of what an instrument will sound like. I think the extra effort required to produce the tapes would be better spent working on articles.

Ross Mohn

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I am a rather recent subscriber and am writing to let you know how much I appreciate this publication. As a composer with an interest in instruments of original design and timbre, I must say you guys save me a lot of time I'd otherwise be spending trying to figure out who's doing what etc.

In your last editorial you posed the question regarding your producing tapes of the instruments mentioned in the publication. I think this is a great idea and know several other composers who would buy such tapes if you took the time to make them. So here's a big vote in favor. I hope others have written to express the same.

Thanks again for your wonderful publication,

Stephen Taylor

****

GOURD INSTRUMENTS MADE AND PLAYED BY MINNIE BLACK

Since biblical times and before, gourds have been used in many cultures for purposes musical, sculptural and practical. They have been bred, over the years, for an astounding variety of sizes and shapes. They are often very beautiful, and suitable for countless applications. And although it has not been widely heralded, gourd culture here in the U.S. is currently thriving and expanding. A network of growers and users has developed, making all manner of gourd seed and cured gourds available from many sources both commercial and casual, as well as disseminating information and providing some camaraderie among devotees. At the center of this network is **The Gourd**, a twelve page newsletter published three times a year by the American Gourd Society, available for $3/year from P.O. Box 274, Mt. Gilead, Ohio.

Musical instrument building is one important facet of all this gourd activity. In addition to the traditional gourd instruments associated with East Indian, African and other cultures, there are a number of people in the U.S. building non-traditional gourd instruments of all sorts. This is not surprising: their musical quality and the great variety of shapes available makes for a near irresistible invitation for any builder. Seeds are available to produce conical tube shapes twisted every which way, cylindrical tubes likewise twisted or straight, hourglass shapes, shapes with long thin necks and bulging bellies, all sorts of globes and flattened globes, and any number of other unexpected forms. Furthermore, sophisticated growers can breed for specialized forms or train growing gourds to specific shapes.

In a future issue, EMI hopes to run some practical information on the cultivation, curing and subsequent working of gourds with an eye to musical purposes. We will also bow at that time to several of the other gourd instrument builders doing interesting non-traditional work today. But for now, let's get to the subject of this article, the gourd instruments of one very special builder, Mrs. Minnie Black of East Bernstadt, Kentucky.

Minnie Black, now 87 years old, was raised on a Kentucky farm. Always plenty of hard work, she reports, and always plenty to eat. For most of her adult life she was married to a railway agent. She began her work with gourds later in life, after his death.

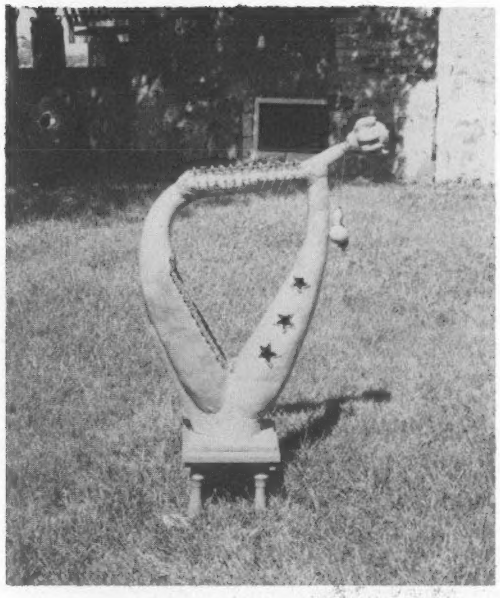
Her work takes many forms. In addition to the musical instruments discussed below, she has fashioned gourd jewelry, hats, and human and animal figures. Some of these are quite fanciful, while some of the figures, including what are surely the world's only self portraits in gourd, are realistic. The work is collected in her Gourdcraft Museum in East Bernstadt.

Her gourd musical instruments have won Mrs. Black a goodly amount of recognition as a folk artist. She has performed with them widely, at prestigious events like the Knoxville World's Fair as well as many homier functions. In most of her early appearances she sang and played the gourd ola (a mandolin-like instrument), a gourd fiddle, or a gourd-resonated mountain dulcimer. More recently, she has formed the Gourd Band, a full ensemble of gourd instruments with something under twenty people playing various wind, string and percussion instruments made by Mrs. Black.

The instruments use many different types of gourds, some of them trained to particular shapes during cultivation. After drying and curing them, Mrs. Black uses a saw to make whatever cuts are required for the particular instrument. If two or more gourds are to be joined, she uses a product called "Sculpta-Mold", which adheres and hardens better than plaster of paris, and can be sanded and painted when dry. The instruments occasionally call for additional parts of bamboo or wood. Strings are usually standard instrument strings made for guitar, banjo, mandolin or such, and drumheads are rawhide. Decorative designs on the surface of the gourds are done by burning with a wood burning tool, carving with woodcarving chisels, or painting. (Indeed, decoration of gourds is an established folk craft in its own right, with many practitioners.)

Mrs. Black has made at least fifteen or so different types of gourd instruments. From among them a smaller number have been chosen to represent her work here. Their descriptions and photographs follow.

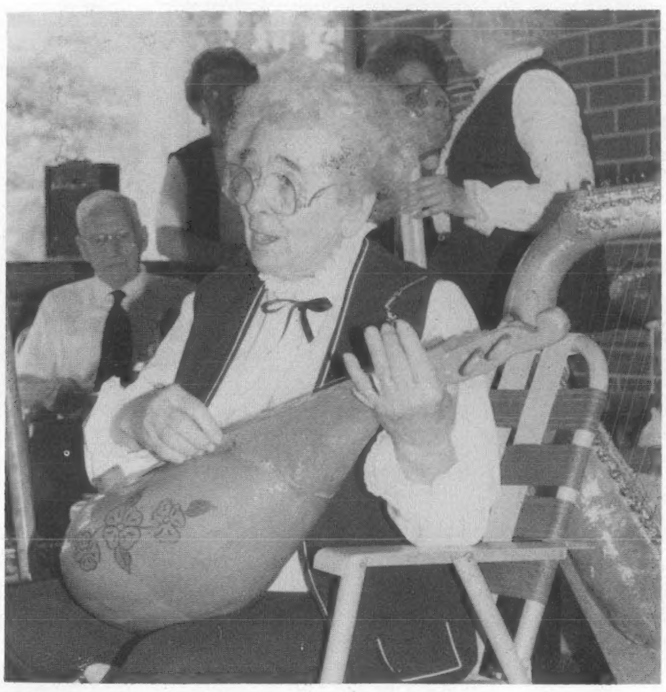
THE GOURD BAND IN PERFORMANCE

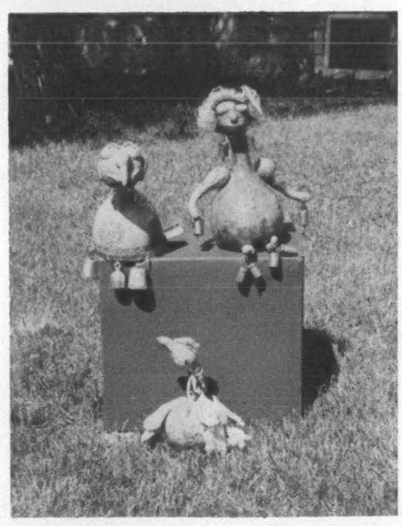


THE GOURD HARP is made from two large Guinea Bean gourds, with a Crown of Thorns ornamental gourd mounted at the end for decoration. The gourd on the left in the photograph has a 3" x 16" strip cut out where the lower ends of the strings pass through and into the gourd without touching. They cross the interior of the gourd and are attached at the opposite side (that is, below left) to a wooden reinforcing strip. At the upper end they are fixed to machine pegs mounted on another reinforcing strip. The twelve strings are standard guitar strings. Three star-shaped cut outs in one of the gourds serve as sound holes.

The upright four-string instrument shown here uses a Lucca gourd, about 25" high and 26" in circumference. A small ornamental gourd crowns the top. The neck is bamboo, running all the way through the body of the instrument to the bottom of the resonator gourd. Tuning is done by means of violin-style hardwood pegs in holes drilled through the bamboo. The fret board, extending all the way to the base of the instrument, is wood. Also of wood are the nut and bridge. There are metal frets, and banjo strings are used in a banjo tuning.

THE GOURD OLA is made from a gourd of mixed parentage, which therefore can't really be identified by type. The instrument itself is similar to a mandolin in form, but with four single strings tuned like a banjo. The peg head, pegs, and bridge are of carved wood. The fret board too is wood, with frets of stainless steel wire. In the photograph the instrument is played by Mrs. Black herself.

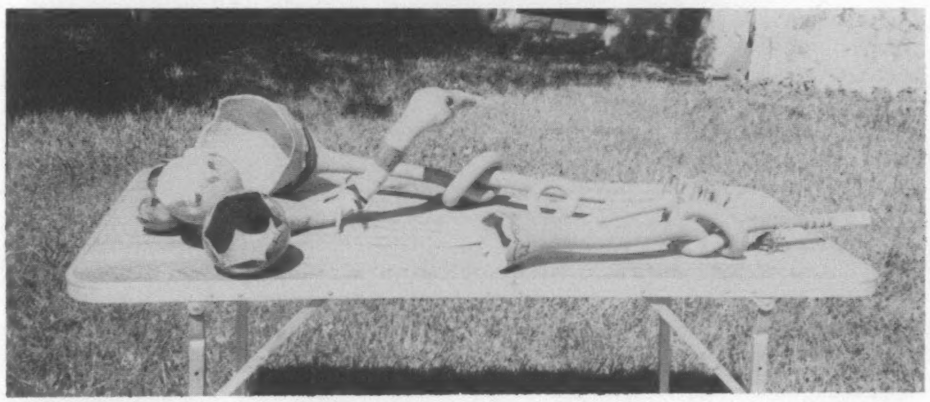




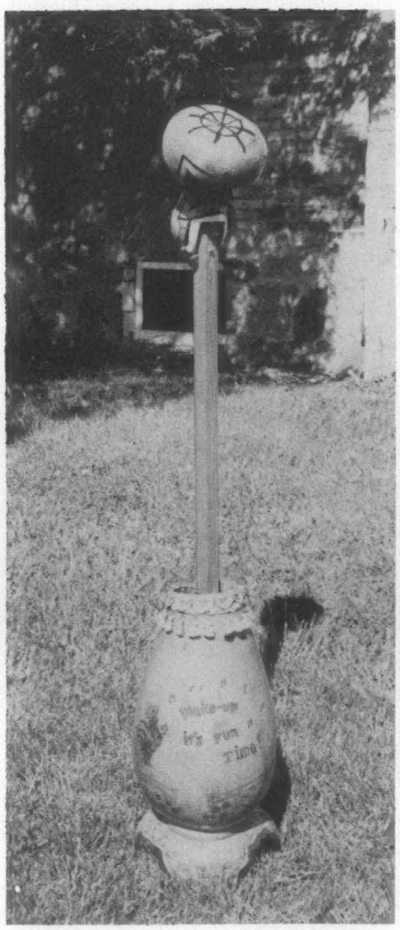
The FUN INSTRUMENTS shown here are made from Indonesian Bottle gourds. The loosely-attached arms and legs have bells for hands and feet, which ring as the player taps the little guys on the stomach.

The bass drum shown here, reminiscent of some types of friction drums as well as a wash tub bass, is made from a Nigerian Giant gourd, sixty inches in circumference and twenty inches high. The head of the drum is rawhide, affixed with white glue and upholstering tacks. An upright stick is attached to the side, and a single wooden tuning peg is set into it at the upper end. The string of fine wire or strong nylon cord runs from the peg down through a tiny hole in the drumhead. At its lower end of the string a bottle cap is attached, which pulls firmly up against the drumhead from below when the string is tightened. The player can either strike the string with a small plastic beater, or play the rawhide head with mallets.

Mrs. Black has made a number of other membranophones not shown here. They include, among others, an hourglass drum, a triple-headed drum, and a drum looking very much like a long necked string instrument minus the strings. On this last one, there is a drumhead where the soundboard might have been. It is played played standing up by holding the neck upright and striking the head with beaters made, naturally, of small gourds.



These beautiful instruments are resonated KAZOOS, each one made by placing store-bought kazoos in the stem end of the long neck of a Handle gourd. The knots appearing in some of them were made by tying them while still on the vine.



The instrument shown here is so unusual in its design as to be without a name. The large lower gourd is a Lucca gourd, mounted on a stand carved from another gourd of the same type. The upright post which supports the strings is wood, with metal tuning pins at the top. Above that is a Thick Neck Birdhouse gourd, which, being attached as it is to the piece which supports the strings, serves as the main resonator. The player strikes the strings with a light plastic beater. There are no frets, and the instrument acts more as a timekeeper than as a melody-maker. The inscription on the lower gourd, with a picture of a rooster crowing, reads "Wake up! It's fun time!"

THE WATERPHONE (continued from page 1)

in 1968, Richard chanced to see a kalimba in the hands of a street musician in a Haight Ashbury parade. He was attracted to the instrument for both its sound and its appearance. He also was drawn to it by the fact that a world of lovely sounds was available to anyone picking up the instrument for the first time: relatively little stood between the novice and the music.

Richard applied the skills and tools of a sculptor to what he had seen -- for sculpting was his stock in trade, and where his training had been. He put together some tin-can sansas, spidery-looking things with tongues of wire welded to metal resonators. He did not have the kind of academic musical background that would lead him to produce specific scales; he was simply after objects of interesting appearance capable of producing the sounds he was drawn to.

Another chance encounter which had taken place earlier now enabled him to go a step further. At the house of a friend, he had had the opportunity to see and play a Tibetan water drum. There are different types of instruments commonly called "water drums;" the one that Richard played consisted of a bronze, flattened sphere with an aperture, and water held inside. Richard spent a long evening exploring the possibilities of the instrument. He was taken with the way in which the moving water within brought about a continual bending and shifting of resonances in the body of the instrument after the tone was first sounded.

In the meeting of the memory of this experience with the welded metal sansas he had been making, the idea for the first Waterphone took hold. Richard began welding metal rods to metal resonators which could be filled with moving water. The extraordinary acoustic effects of the Waterphone began to appear. He found that, while striking the rods and the body of the instrument produced fine results, the most ravishing sounds were to be obtained by bowing the rods. Time passed, and the Waterphone design and construction methods continued to evolve and improve.

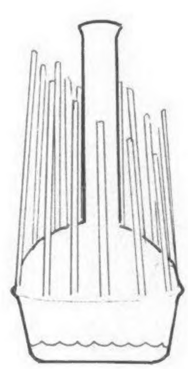
Before too long, people outside of Richard's immediate sphere began to take notice of the instrument. The first well-known and influential person to pick up on it was jazz drummer Shelley Manne. Through him the Waterphone found its way into the collection of percussionist Emil Richards, and from there became known to an increasing number of studio musicians operating in and around Los Angeles. Its widest exposure came with Jerry Goldsmith's soundtrack for the movie **Startrek**, but that is just one of a very respectable list of recordings, compositions, performances and sound tracks in which the Waterphone has figured. Richard himself has performed on the Waterphone with a number of ensembles, most notably the Gravity Adjusters' Expansion Band, and more recently, Totem.

The Waterphone is one of very few truly new and unconventional acoustic instruments that has been sold commercially with reasonable success. While they may not appear to be taking over the world, Waterphones, still made individually and by hand, have sold in sufficient quantity to cover costs and give the maker some modest recompense for his efforts. As great as the appeal of the instrument may be, this did not happen without considerable on-going effort and stick-to-it-iveness on the part of Richard and his wife Christine. One of the greatest difficulties has been preventing others from selling imitation Waterphones to the potential buyers the enterprise depends on. Richard has responded to this in several ways. He has promoted his work carefully with brochures, flyers, demonstration cassettes and albums of music. He has kept a step ahead of other would-be builders by continuing to improve the instrument and developing manufacturing methods which are difficult to imitate. And he has patented the instrument, and made the effort necessary to keep the patent active (patents do go stale with time). Please notice this -- readers of this article are asked to respect the patent and refrain from attempting to capitalize on the construction principles here described.

THE WATERPHONE AS IT IS TODAY -- A DESCRIPTION

The Waterphone as Richard makes it today is a refinement of the idea that originally took shape through the sansas and water drums. The acoustic principles are the same; the materials, formal details and construction methods are considerably advanced. With the process of evolution and refinement, a family of instruments has grown up. Waterphones now appear in several sizes, with some variation in shape. The description that follows is of the most widely used of the group, the Standard Waterphone.

The body of the instrument is made up of two stainless steel bowls, seven and one half inches in diameter, welded together to form a globular base. From the top of this form rises a stainless steel cylindrical column an inch and a half in diameter and eight and three quarters inches high. Around the periphery of the globe are welded forty-two bronze rods. They stand not quite upright, leaning slightly toward the stainless steel column at the center. The tallest is just



under a foot long, the shortest about four inches, and they are graduated in length in an irregular pattern in keeping with Richard's tuning methods (more on that later).

Water is placed inside the body of the instrument. Large amounts have the effect of dampening the vibration, so the quantity of water is kept to about $\frac{1}{4}$ cup -- just enough to cover the bottom shallowly when the instrument is upright, and run up the sides a bit when it is tilted.

PLAYING THE WATERPHONE

These three elements -- the stainless steel body, the bronze rods and the water within -- form the essential instrument. They can be played any of several ways. Because of the extraordinary acoustic properties of this combination of elements, almost any means of exciting a vibration anywhere in the instrument will produce an intriguing sound of some sort. The most common means of excitation is by bowing the rods. Richard uses a standard bass bow rosined in the usual way. The instrument also is often played by striking the rods or the body of the instrument with the hands, or with soft rubber mallets. (As accessories to the instruments, Richard sells a fiberglass bass bow and pairs of superball mallets.) On the larger, flat-bottomed instruments the player can also use the superball mallets, with their high traction, to sound the instrument by friction, dragging the ball slowly along the bottom with moderate pressure.

As the instrument is sounding, the player tilts, rocks or rotates it, so that the water

THE WATERPHONE FAMILY. Above: R.S.G. (Revolving Sound Generator). Below: Bass, W.R.F.B. (Wide Range Flat Bottom), and Standard Waterphone.

Photo by Lenny Cohn

inside moves and sways. This alters the natural resonating frequencies of the body, and brings about the peculiar pitch bending and timbral shifts that are so characteristic of the sound.

The sound of the bowed Waterphone is strikingly reminiscent of whale songs. Waterphones have been used in whale watching and research expeditions in Mexico, Hawaii, the South Pacific and elsewhere. Whales have indeed been found to respond to the sound, gathering and displaying apparent interest and curiosity. An alternative bowing technique has been developed for this application. The Waterphone is taken into the water, inverted and bowed with a non-oily, wet finger. This type of hand-bowing can also be used for performance in swimming pools or just a bucket full of water.

TUNING

By bowing the Waterphone's rods at different points along their length one can isolate different overtones as the sounding pitch. On a single Waterphone rod there are about four or six readily-producible pitches, ranging from extremely high to subsonic or nearly so. The forty-plus rods on the instrument, each with its several modes of vibration, create a profuse and diverse intervalic pallet.

Although the overtones of the Waterphone's rods may seem unruly at first, and pitch bending is an essential part of the instrument's character, it is possible to produce deliberate, controlled definite pitches. A few Waterphone players have worked in this mode, seeking out and labeling the rods for their pitches and in some cases tuning them to particular scales by shortening individual rods to raise their pitch. Most players, on the other hand, have not chosen to produce definite scales on the instrument, but to concentrate on exploring its remarkable timbral possibilities, accepting the available pitches as given.

Richard himself gives a great deal of thought to the question of tuning as he manufactures the instruments. But he has resisted deliberately tuning to standard diatonic or chromatic scales. In what could be described as a sculptor's approach to sound, he tunes each Waterphone individually to a mixture of smaller intervals (approximately one half tone or less) and larger intervals (up to about a minor third), chosen not for specific pitch relationships but for an overall intervalic sweep that is attractive, interesting, challenging or flowing.

He tunes for timbral quality as well. Since there is a lot of communication between the rods through the body of the instrument, the natural resonances of one will affect the resonating behavior of others. As a result, the tuning of the whole set influences the timbral quality of the individual rods. Metal rods tend to have many very prominent partials, and conflicts between dissonant partials occur frequently. Much of Richard's tuning process aims to reduce such conflicts and bring out constructive relationships between the partials.

As part of the tuning process Richard also considers the pattern created in the arrangement of the graduated lengths of the rods. Over the years he has used a number of different arrangements of longer and shorter rods. One that is frequently used currently incorporates two overlapping patterns: the set made up of every other rod comprises a row of progressively longer rods, creating an upward spiral as it circles the perimeter of the globular body. The complementary set of every other rod becomes progressively shorter, creating a downward spiral within the upward one.

THE ACOUSTIC BEHAVIOR OF THE WATERPHONE

As the Waterphone is usually played, the stainless steel body serves primarily as a resonator for vibrations generated in the rods. But the two are not really so very separate or independent in their functions. Their operation is highly interactive. This is one of the keys to the extraordinary acoustic effect of the instrument. All of the metal elements -- the stainless steel body and the bronze rods -- are welded firmly together to create a single, monolithic piece. As a result, vibrations are transmitted readily throughout the instrument: when one rod vibrates, the entire instrument sings. The flat base of the instrument, on which the water sits, seems to have an important role as a partially independent diaphragm. When the water shifts and as a result covers the diaphragm to a greater or lesser extent, it has profound effects on the vibrations as they travel through the metal. The results are some of the strangest and most beautiful sounds imaginable.

The effects of the water on the overall vibration seem to be of two sorts, which can occur simultaneously. Both result from the fact that as it shifts position it changes the natural vibrating frequency preferences of the body of the instrument, independent of the rods. This can be demonstrated by holding the instrument upright, tapping the body and listening to the pitch; then tilting it (altering the position of the water within) and, after the water has become still, tapping again. A new, higher pitch is produced. The steeper the angle of tilt, the higher will be the pitch of the tapped resonator. In normal playing conditions, discrete pitches of this sort in the resonator rarely come into play, but as the player causes the water to sway and swell, the natural vibrating frequency of the body of the instrument is in a continuous state of flux.

The first effect of this resonance frequency shifting is to cause timbral shifts in the tones from the sustained vibration of the rods. For any given position of the water, and corresponding set of frequency biases in the resonator, certain overtones in the vibrating rods will be enhanced while others are de-emphasized. As the water moves, and with it the predilections of the resonator regarding which frequencies to respond to most readily, the overtone make-up of the tones originating in the vibrating rods changes as well.

The second effect of the water movement and resulting resonance frequency shift concerns vibrations occurring primarily in the body of the instrument. In most cases these are vibrations initiated in the rods, and communicated into the metal of the body. The flux of the water does not

cause much change in timbre in the body tones. Rather, it causes them to bend in pitch, and quite dramatically at that.

These two effects -- timbral shifts in the rod tones and pitch bending in the body tones -- can and do happen at the same time. The vibration initiated in the rods and communicated to the body continues to resonate in both places. Changes that the now partially independent vibrations go through may affect one another, but the two don't seem inclined to damp one another out. The acoustic result of the simultaneous occurrence of the two acoustic behaviors -- overtone shifting and pitch bending -- is somewhat analogous to flanging, an effect found in many signal processing units available for electrified musicians. But in the Waterphone there is an unpredictability, a wildness about it, which give it an entirely different feeling. And when many rods are initiating many vibrations, often at microtonal intervals, all undergoing these multiple transformations, the effect is bewitching.

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FOR MORE INFORMATION

The instruments described here are available from Richard Waters. In addition to the Waterphones, Richard has designed and built a varied lot of other new instruments and sound devices, many of which, like the Waterphones, take advantage of the shifting water effect. Brochures containing descriptions, illustrations and prices for the instruments of the Waterphone family and the other types are available. A demonstration cassette with music from all of the instruments is also available for $8, deductible against the subsequent purchase of one of the instruments. For most of the instruments there are standard sizes and forms, but they are continually evolving and undergoing improvement. Special designs and customizing of the instruments can easily be arranged.

The address for purchases or further information is

Richard Waters
1462 Darby Rd.,
Sebastopol, CA 95472.

Several recordings which include Waterphone music are commercially available in addition to the demonstration tape mentioned above. Richard recommends **Three Worlds** by Mel Graves and **Marshland** by George Marsh, both on the 1750 Arch label, available through New Music Distribution Service (500 Broadway, New York, NY 10012). **Hole in the Sky** and **One**, both albums recorded by the Gravity Adjusters Expansion Band (of which Richard was a member), are now out of print, but cassette copies from the disk are available for $7 plus $1 shipping from the address given above.

WATERPHONE PLAYED BY RICHARD WATERS

PRINCIPLES OF MALLET DESIGN
Approaches to Mallet Making
for Various Types of Percussion Instruments

by Rick Sanford

Today's percussionist is bewildered by the world of experimental instruments and the odd techniques required to play their diverse, hybrid designs. The world of homebuilt instruments also places demands on the sticks and mallets of the musician, and most experimental percussion instruments require their own mallet set. This article will explain basic mallet theory and provide the reader with the ability to, if not make his own set of mallets, at least choose the appropriate stick for a given instrument.

Two basic rules of mallet design:

1) The size and weight of the mallet must correspond to the size and weight of the instrument.

A bass drum mallet, for example, must drive the weight of two heads plus the weight of the air BETWEEN the heads for the instrument to be sounded. The mallet also must strike a large enough area that it does not poke through the head it strikes!

2) One elastic element must be present in either the mallet or the instrument.

a) A rigid instrument (temple block, gong) requires a mallet with a soft core (e.g. rubber)

b) An elastic instrument (drum) requires a mallet with a solid core (e.g. wood)

In this article, we concern ourselves with "tone production". We will not deal with odd sounds or special effects, such as the African drum stick made of a bundle of bicycle spokes, the effect of a bullwhip upon a bass drum, or attacking gongs with chainsaws. We are interested in the means by which sonorous bodies are set into motion at different playing volumes.

One term that will crop up from time to time is "striking area". This is the portion of the stick which touches the instrument. The shape and size of this spot, regardless of what covers it, gives our resultant sound to a great degree.

With most mallets, a soft covering cushions the blow, taking away the brittle contact sound of raw wood upon wood, metal upon wood, plastic, etc. A cardinal rule from timpani playing explains: "Use as soft a stick as the music will allow". This reflects the philosophy that the beauty of a struck instrument lies not in the striking itself but in the sustain that follows, and a softer mallet tends to maximize this sustain. Hard sticks find their use in passages requiring rapid rhythmic execution, where the cushioned strokes of a soft stick would run together, losing articulation.

A general purpose mallet, then, has two parts: a handle, or shaft; and a head. The head itself is comprised of a core, and undercovering, and a covering.

1. HANDLE -- Wood, metal pipe (aluminum works well), plastic, rattan, bamboo. May be rigid or pliable, as in the case of rattan marimba sticks.

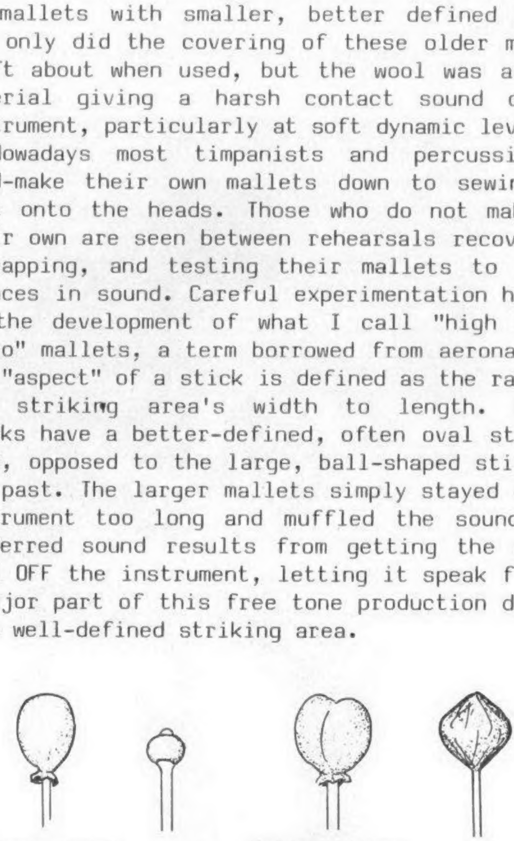
2. CORE -- Ideally the densest part of the stick and the part giving the head its size, weight, and general shape of striking area. May be made of wood, cork, rubber, rope, layers of masking tape, etc.

3. UNDERCOVERING -- A thick layer of felt, cloth, leather, baby yarn, or foam determining the mallets' hardness and acting as a cushion between the solid core and the covering, to save wear on the covering.

4. COVERING -- Ideally as soft as possible. May be yarn, cotton felt, piano felt, macrame cord, nylon, etc.

Common beaters of years ago consisted of a heavy felt or cork core over which was sewn a sack of lambswool. The vogue in recent years has been to mallets with smaller, better defined heads. Not only did the covering of these older mallets shift about when used, but the wool was a rough material giving a harsh contact sound on the instrument, particularly at soft dynamic levels.

Nowadays most timpanists and percussionists hand-make their own mallets down to sewing the felt onto the heads. Those who do not make all their own are seen between rehearsals recovering, rewrapping, and testing their mallets to adjust nuances in sound. Careful experimentation has led to the development of what I call "high aspect ratio" mallets, a term borrowed from aeronautics. The "aspect" of a stick is defined as the ratio of its striking area's width to length. Modern sticks have a better-defined, often oval striking area, opposed to the large, ball-shaped sticks of the past. The larger mallets simply stayed on the instrument too long and muffled the sound. The preferred sound results from getting the mallet head OFF the instrument, letting it speak freely. A major part of this free tone production depends on a well-defined striking area.



TYPES OF COVERING

Typically, felt is used as a covering for

drumsticks, while yarn-covered mallets are used on wood and metal instruments. The elastic drumheads "give" easily, whereas metal instruments are non-elastic and will rapidly wear a felt covering. Yarn tends to be more durable and does not muffle vibrations like felt coverings may.

Felt coverings are either a strip made into a short tube and sewn, or a "sack-type", where thread is looped around the perimeter of a circle of felt and pulled tight, making a ball covering which is stretched tightly over the stick.

The wrapping of yarn mallets is an art in itself, and shockingly few musicians bother to learn the intricacies of its technique. Basically, yarn is looped continuously over the mallet head and back alongside the handle, while the stick is slowly rotated so that each winding covers a new part of the head. Sometimes a few lateral wraps are applied first (See 1 below), to soften the stick or give a sharper striking area, then are followed (2) by normal wraps.

An important rule is to make the loops equal distance from each other (3), assuring an even covering with no thick or thin spots (4), which lead to uneven sound quality.

Once the desired softness (layers of yarn) is obtained, the wraps are sewn at both the crown of the head and the base, close to the handle. Also, a very adequate and fast way of sealing the loops of yarn is to apply glue from a hot glue gun to these spots.

A THIRD RULE OF MALLET DESIGN:

3) Each new layer of material on the mallet head should be softer than the preceding.

(1)

(2)

(3)

(4)

In other words, the core should be of the hardest material, followed by a softer undercovering and an even softer final covering. Other combinations lead to peculiar effects. An unpleasant sound will result, for example, if our undercovering is of latex foam and the covering is of thick nylon twine. When used softly, a mallet like this would only produce sound by its covering, as the foam undercovering would absorb all the striking force, never allowing the weight of the stick to reach the instrument.

This combination, oddly enough, is common in the mallets provided with Thai and Javanese gongs. The ornately spun and decorated mallets often contain layers of loose cotton cloth as the undercovering, covered by a woven sack of cord. This woven covering is denser than the cotton underneath and, while loud strokes with the mallet project adequately, these mallets lack sensitivity for playing at other dynamics.

WHY AN UNDERCOVERING?

Most wrapped mallets, including those of the gamelan, contain an undercovering. A firm undercovering helps absorb impact, preventing the mallet core from grinding and rapidly wearing the covering. Also, a thick undercovering makes wrapping simpler and faster, since fewer layers of covering are necessary to achieve the desired softness.

Most felt-covered timpani sticks involve no undercovering, but it is necessary to continually "fluff" the outer felt layer to avoid a tacky contact sound. Here, a tighter covering acts as its own undercovering.

The most significant need for an undercovering, though, regards sound and dynamics. When a wrapped mallet strikes, the layers of covering compress. During loud playing the covering may compress entirely and become ineffective, letting the core cut through and sound the instrument as if no wrapping exists.

There is a style of marimba mallet called a "blend", where a hard, tightly wrapped undercovering of yarn lies beneath a very loose, softer yarn covering. When used quietly, the covering cushions the strokes, allowing smooth legato playing between notes. As the dynamics increase, these loose layers separate, compress and allow the harder undercovering to "bite" through, giving punctuation to rhythmic lines. Without an undercovering, the core itself would sound the instrument and most likely damage it.

A common practice, too, is to have the beginning layers of the covering very tightly wrapped and successive layers looser.

Obviously the performance

situation will dictate much of the mallets' characteristics: If an instrument is to be played only loudly, then a delicate covering may not be necessary, where a substantial core and the undercovering would. In such a case, a more durable covering, such as nylon yarn or heavy felt, would prolong the life of the mallet without compromising sound quality.

SAMPLE CASES

So far we have talked about mallet theory. Let's imagine some instruments and try to create the right mallet for them.

Instruments A and B are keyboard metallophones. Each has long metal keys which are struck. The bars of A are ½" diameter solid iron, for example, rebar, and are from 1' to 2' long. The bars are suspended on cords in a frame with no resonators. Instrument B is made of brass tubing one inch in diameter, and the tubes are from 2 to 3½' long.

Though the tubes of instrument B are larger than A's rods, the weights of each are roughly the same, since B is hollow and A is not. This tells us that the mallets for each will be similar in weight, but will be different in many other ways.

The rods in A are held taut on strings, and since they are thin, require a stick with a small head. Some elastic property is necessary, and it is decided that a flexible handle of rattan will be best. A flexible core of rubber could be used instead, but the mallet needs a density and hardness to match that of the solid iron rods, so a solid core is the best choice. For this mallet, small (1" round) heads of hardwood or plastic would be mounted on shafts of rattan or flexible plastic. The head would then be wrapped in a durable macrame yarn, perhaps protected by a thin layer of moleskin (Dr. Scholl's) as an undercovering.

B is a chime-like instrument, with vertical hanging tubes. The tubes are larger diameter and longer than A's rods, and swing considerably when struck. The main considerations here are that the mallet head be large (to match the size of the tubes), and the handle rigid so that strokes upon the tubes are deliberate, since a swinging tube may be heading TOWARD the mallet which is trying to drive it AWAY.

We are tempted to use a rubber core for elasticity, but this would yield too heavy a mallet due to the required head size. A better choice for the core would be a cylinder of plywood, carved pine, or other lightweight solid wood. Over this we would place a rubber undercovering, perhaps made from bicycle inner tubes, and finally a wrap of soft wool or nylon yarn.

Our basic rules of design are employed here to match the size of the instruments to appropriate sticks, to govern how the weight or density of the mallet head will match that of the surfaces being struck, and to provide and effective elastic coupling between solid handle and solid instrument.

MALLET MANNERS

Picking up a percussionist's mallets is like taking a violinist's bow, and there are some courtesies expected.

Do not judge a stick's hardness by squeezing the mallet head between the fingers. This compresses the layers, giving an uneven wrap, and transmits oils from the hand, which decay the covering and make it susceptible to dust and dirt.

The proper way to assess a mallet's hardness is to simply strike an instrument with it. And preferably the RIGHT instrument! Don't hit a wood block with a felt timpani beater; remember rule #1 and the striking area. Striking softly at first will give an idea of the mallet core's hardness; some mallets are meant only for rosewood or tempered metal instruments and may damage delicate bronzes or woods.

Rattan mallets also need particular care. The handle may suddenly break if waved in the air without striking anything. Flexing of this type is very damaging to rattan, and one should always test the feel of such mallets by striking, not by swinging in space.

SOURCES AND TOOLS

HARDWARE STORES -- good places to find wood doweling for handles, assorted rubber bumpers for mallet cores, and twines, string, and weather-stripping used for undercoverings. A necessary tool for attaching cores to handles is a supply of 24-hour epoxy or a hot glue gun.

FABRIC STORES -- The bigger the better: a five-and-dime will have the basic yarns; baby yarn for dense undercoverings, nylon for general purpose, worsted for soft outer layers. A larger store will also offer long-lasting macrame yarns and a selection of foams for undercoverings and sheets of felt.

PIANO SUPPLY COMPANIES -- Red piano damper felt has many uses in mallets, and is easy to come by. The advantages of piano felts are the amazing softness available and the blanket-like thickness.

A block plane, wood rasp, sandpaper and small coping saw can make a darn impressive mallet. A drill is essential. I've always had good luck using wood boring bits to drill heavy rubber cores, despite the smoke and smell. I also use heavy leathercraft needles to do my yarn sewing and a small pair of dressmaker's scissors for cutting the mallet head components.

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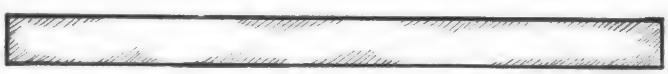
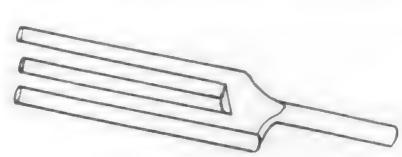
Rick Sanford, author of this article, is a percussionist living in San Francisco.





RECORDINGS

SONDE EN CONCERT
Sonde

LP record on the Music Gallery Editions label, 30 St. Patrick Street, Toronto, Ontario, Canada, M5T 1V1. Also available from New Music Distribution Service, 500 Broadway, New York, NY 10012.

Sonde is a group of six musicians -- Charles de Mestral, Andrew Culver, Keith Daniel, Pierre Dostie, Chris Howard and Linda Pavelka -- centered in Montreal. They play improvised music on an array of new musical constructions and modified or unconventionally-played traditional instruments. Their improvisation focus on texture, timbre and temporal development and do not concern themselves with definite pitch relationships or rhythms based on regular pulse. The heart of their work, as the musicians themselves see it, is in the creation and modification of the sound sources. In the liner notes to this record Charles de Mestral writes:

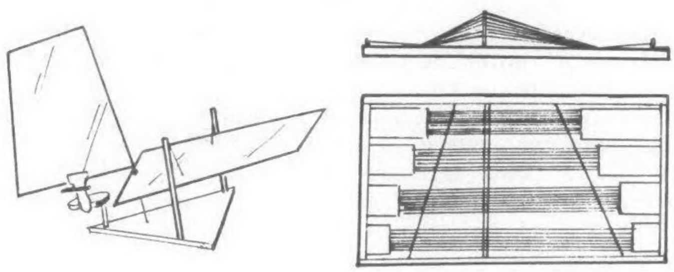
Mario Bertoncini showed Le Groupe Mud [an earlier name for Sonde] that music can be made from 'sound sources' which the musician conceives and makes himself. This activity, which he calls 'musical design', is not the same as instrument building. An instrument can play any number of different pieces. On the other hand, the sounds available from a 'sound source' constitute a single piece. This is a kind of sculpture in sound in which no parts are predetermined and in which the only guide is the kind of sound one wants to explore.

Most of Sonde's instruments are amplified electronically, by means of contact microphones, conventional air microphones, or magnetic guitar pickups. The group sees amplification not so much as an electrification of the sound, but rather as a means of deeper acoustic exploration. The microphone is used to reveal microsonic worlds of tiny acoustic events within whatever materials are being used for sound sources. Having converted the signal to an electronic medium, though, the group is not above carrying the possibilities a bit further with various forms of electronic signal processing.

The **Sonde en Concert** LP contains seven pieces based on five instrument types.

"Les Plaques" uses a number of steel sheets in various shapes and gauges, mounted by clamping, balancing or suspension by wires. Vibrations are excited in the sheets by percussion and friction, and the sounds are picked up by close miking. The improvisation captured on the record is, over most of its length, open and spacious; it refrains from developing any motoric or forward-moving feeling, and instead invites the listener to focus on the quality of the sounds themselves. The quality is peaceful at times, frightening at other times.

"Sahabi II" and "Sahabi III" use a pair of more elaborate constructions. The Sahabis are arched zithers, each of which has four groups of ten to thirty closely-spaced strings. The strings within each bank are tuned microtonally close (all of them, for instance, within the range of about a minor third). The player uses a bow, making no attempt to isolate individual strings, but playing some, most, or all of the cluster with each stroke. Guitar pickups on the body of the instruments pick up the vibration. In one of the two Sahabi pieces the signal is sent to a tape-delay reverb and filtering arrangement operated during performance by one of the group members. The sound of "Sahabi II" is beautiful, strange, mysterious and enchanting. It is also, unfortunately, reminiscent of outer space movie soundtracks, and the listener has to try to banish this association before being able to freely appreciate the instrument in its own right.



LES PLAQUES AND SAHABI

The piece entitled "Flutes/Modulation" uses recorders, fipple flutes and slide whistles, with the sounds of half the group modulated against those of the other half through a ring modulator. The result is a chirpy, happy affair sounding alternately natural/pastoral and R2D2 goofy, depending on how much intermodulation is going on at the given moment.

The remaining pieces are "Voix", a blend of lots of voices and a little percussion, aided by tons of tape-delay reverb, and two short "Mudiatures", which use cymbals, gongs and a six foot piece of cedar. The "Mudiatures" are wonderfully refreshing little things, comprised of a capricious mix of percussion sounds which say all they wish to say in fifteen seconds or so and then graciously leave the listener to his own thoughts.

This record was produced in 1979. Since then Sonde has remained active and continued to develop new sound sources. Recently much of the exploration has centered on the peculiar micro-acoustic qualities of soft materials. Group members have been investigating the sounds to be found in water, air and the human body, as well as sheets of mylar, rubber, and polyethylene. They continue to perform in Canada and abroad, doing theater, dance and film work along with concerts and exhibitions.

No new recordings have become commercially available since the En Concert LP. Informally-produced cassette recordings of Sonde's recent work can be obtained from Charles de Mestral, 3912 rue de Mentana, Quebec, Canada, H2L 3R8. Write for further information.

INSTRUMENTS

THE MALLET KALIMBA
Conceived and built by Darrell Devore;
Version described here built by Robert Rich

Article by Robert Rich

Sometimes the simplest instruments are the most satisfying to play. A bamboo flute, for instance, can provide an endless wealth of expression. Tuned percussion instruments can be especially rewarding -- particularly in group performance situations. The kalimba is perhaps the easiest tuned percussion instrument to build, and has a few advantages over the marimba family, not the least of which are portability and ease of tuning.

The mallet kalimba described here was inspired by a similar instrument built by Darrell Devore, a friend of mine who has built some very unusual, simple and wonderful sounding instruments. This is a perfect beginner's project, and can be built for under $10.

Since much of my work involves just intonation, I like this instrument for the ease at which it can be re-tuned. The portability of the mallet kalimba makes it very easy to take to performances. Despite the simplicity of the instrument, it is very easy to record, and appears on my most recent album.

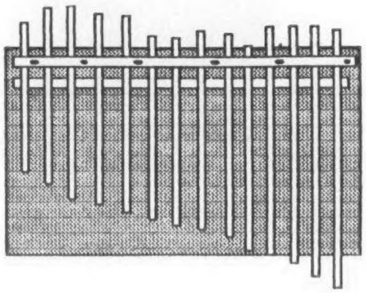
This instrument has a sharp, bright percussive sound with many unusual overtones, and it is surprisingly loud considering what it uses as a resonator (more on this later). Its sound seems to hover somewhere between an African mbira and a Balinese metallophone.

One needs the following materials for construction:

- aluminum or steel rod, 3/8' diameter (steel is better if you can drill through it.) Available at most large hardware stores.
- small wooden half-dowel. Available in consumer-oriented lumber yards, or in hobby shops.
- heavy gauge spring steel (3/16" x 1/16"). (Source not known. My stock was given to me by a friend. A metal shop should know where to find this).
- flat wide hardboard or pressboard (12" shelving works well). Available at any lumber yard.
- one foam ice chest, found in most supermarkets.
- adhesive rubber or foam strip. Radio Shack sells double-sided adhesive foam tape that works well.
- 1" wood screws.

Remember that the exact dimensions are not that important. This is a very non-critical instrument!

The hardboard is the base of the instrument. The piece I used was 12" by 18". If you are on a budget, even pressboard will work. An actual resonator box will give a richer sound, but is



really not necessary. The foam ice chest fills the role of a resonator quite well.

Construction is as follows:

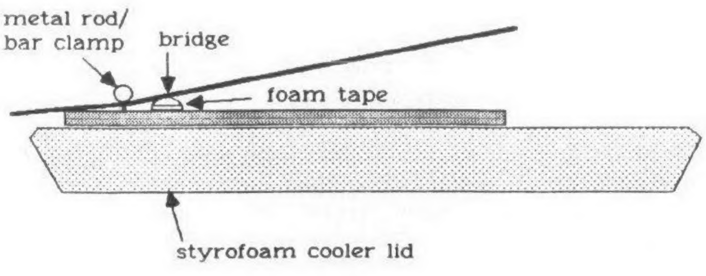
Cut one length of aluminum rod and one length of half-dowel to the dimensions of the long side of the hardboard base - 18" would be typical. The half-dowel forms the bridge, and the aluminum rod will form the clamp for the keys. Drill holes through the metal rod every few inches, or as needed for firm pressure against the keys. (The rod will tend to warp away from the keys if the holes are too far apart. This is why steel is better than aluminum, but very hard to drill!)

Attach the dowel in position for the bridge on the sound board. A layer of rubber or foam should be used between the two pieces of wood to keep the bridge from rattling. Double-sided adhesive foam works both as padding and adhesive. Otherwise, you can tack the bridge into place with small nails, squeezing the rubber between the bridge and soundboard. The pressure of the keys will help hold the bridge firmly. Be careful with nails, though, because they, too, can cause the bridge to rattle.

The next step is to cut the spring steel to form keys. The exact lengths do not matter because tuning is accomplished by sliding the keys to different lengths from the bridge. Lengths should range upwards from about 8" to 18". Spring steel is very hard to cut, but it does break rather easily if weakened. Hack saws do not work very well on it. I recommend using a drill or moto-tool with an emery wheel grinder attachment. Place the steel in a vise and use the grinder to cut a notch into the spring steel at the point where you want to break it. If the notch is deep enough, it should weaken the steel enough that you can break it with a pair of pliers.

Position a few keys on the bridge in order to support the clamp-bar. Place the bar on the tails of the keys, halfway between the bridge and the edge of the board. Start holes for the screws and screw the bar lightly down over the keys. Position the remainder of the keys in order of their length. Now tighten the bar further, but not so much that the keys start to bend.

At this point, you can tune the instrument with a small hammer, tapping the hammer on either end of a key to move it in or out. The keys are easiest to tune when struck with a soft mallet near the bridge.



The note that emanates most strongly from the spring steel is not the fundamental, which in general will be a frequency too low to hear (for the longer keys, even sub-audio). Therefore, a strobe tuner will probably not work well. Tuning by ear, though, is not difficult. Just listen to the loudest harmonic -- it is quite consistent.

Of course, different mallets affect the sound of the instrument a great deal. Cloth covered wood mallets work well, as do ping pong balls. For a ping pong ball mallet, carefully pierce a ping pong ball through the middle to make two small holes, and place through it a very light stick (chop sticks or cane, for example) so that the ball is stuck firmly and will not rattle.

The silliest part of the mallet kalimba is definitely the resonator. For a sharp, percussive sound, use the lid of a standard cheap styrofoam ice chest, inverted with the kalimba placed over the indentation. For a fuller sound, use the body of the ice chest in the same way (this arrangement can rattle a bit, though, when soft mallets are used). My favorite arrangement uses the ping pong ball mallets with the body of the ice chest as resonator, resulting in a bright, ringing tone.

One might think that the styrofoam would absorb and deaden the sound rather than amplify it. It turns out that the cheap, brittle styrofoam that these ice chests are made out of is quite resonant. I am sure that a better resonator exists somewhere, but it is not likely to be as cheap nor as easy to find!

The mallet kalimba is one of those instruments that seems too simple to work. But considering how easy it is to change the tuning of the instrument, and the uniqueness of the sound, I've grown quite fond of it. The usefulness of an instrument is clearly not governed by its complexity!

BOOKS

PRIOR'S REFERENCE HANDBOOK OF MUSIC MATH
by Glen A. Prior

Published in 1985 by Moustache Blue, 15318 Thirteen Mile Rd., Bear Lake, MI 49614. Available from Moustache Blue for $7.00 ($6 + $1 postage). 56 pages long.

With this book, Glen Prior has put together a concise reference book providing the mathematics necessary for dealing with musical intervals on a sophisticated, fairly abstract level.

Prior has taken a no-nonsense approach, packing the pages with the essential information stated without frills or flourish. In fact, there is very little text. Most of the work is comprised of series of formulae, presented in a carefully graded and ordered fashion. Following the presentation of each new equation, one or more examples are given of its musical application. The format for doing so involves presenting a desired result or solution -- for example, "Wanted: frequency of the eighteenth degree in 31-equal when the 0/31st degree is 264v" -- then taking the reader through the procedures necessary to reach the goal.

To get through this material without a restrictive amount of difficulty requires some math background. More important than specific background knowledge, though, is the reader's ability to be comfortable with purely mathematical thought, hopping from equation to equation without a lot of grounding in common language or material analogies.

As a reference work, the book could have been improved by an index, and perhaps clearer structural signposts within the work, such as chapter headings or bold headlines. There is, however, a detailed table of contents serving as a road map through the progression of ideas.

The strength of the work is simply in covering what it does. More and more people are exploring the great world of possible intervalic relationships; more and more are seeking to understand that world and become sophisticated in the manipulation of those possibilities. Information on the basis of equal-tempered and just systems, on how to deal with the exponential oddities of the former and rational convolutions of the latter, has long been widely scattered and hard to get access to. Prior's work addresses this problem directly.

A listing of the main topics covered in **Prior's Reference Handbook** follows:

Logarithms as they apply to the generation of intervals and scale degrees in equal temperaments. (Equal temperaments tend to call for a lot of exponential calculations; logarithms make these more manageable.)

Nomenclature for various equal divisions of the octave, including some interesting, rare and obscure ones.

Derivation of the Pythagorean Comma, the interval of about 1/4 of a semitone which plays an essential role in the tempering of the intervals of twelve-tone equal temperament. (12-equal, Prior notes, can be regarded as 1/12th Pythagorean Comma meantone).

Beats per second, the regular fluctuation in amplitude of intervals whose frequencies are not accurately tuned to small whole number ratios, very useful in tuning. How to determine what the beat frequency will be for a given interval.

Finding the guide tone and the octave tension for a given interval. These two terms are from New Music with Thirty-one Notes, by 31-tone pioneer Adrian Fokker. Their purpose is to help provide a mathematical approach to assessing interval quality and dissonance.

The speed of sound in the air at different temperatures, and how to use that figure in calculating wavelengths and resonator lengths.

Laying out string lengths and stopping points on monochords.

Difference tones and summation tones, which are additional audible "ghost tones" generated by the interaction of two original frequencies.

Keyboard layout and 31-tone tuning information for the Toohoolhoolzote, a marimba designed and built by Prior.

Interval names for 31-tone equal temperament.

Some information on Greek modes.

RECENT ARTICLES APPEARING IN OTHER PERIODICALS

Listed below are selected articles of potential interest to readers of Experimental Musical Instruments which have appeared recently in other publications.

MUSIC MACHINES by Ernie Althoff, in **NMA2**, 1983 (P.O. Box 185, Brunswick, Victoria 3056, Australia).

Line drawings and hand-lettered descriptions of several outrageous and lovable random-rhythm music machines made by Ernie Althoff from mis-appropriated household items, and used in several of his compositions.

THE ANGKLUNG ENSEMBLE OF WEST JAVA: CONTINUITY OF AN AGRICULTURAL TRADITION by Randal Baier, in **Balungan** Vol. II #1-2, Fall 85/Winter 86 (Box 9911, Oakland, CA 94613).

A sociological and historical description of angklung ensembles and their special place in Javanese society. An angklung is a tuned, shaken instrument made of bamboo.

High Performance #34 (240 S Broadway, 5th Floor, Los Angeles, CA 90012) has a couple of reviews related to new instruments in its "Viewpoints" section:

KEN BUTLER: "HYBRID ANTICS" covers a performance by Portland artist Ken Butler, with his eclectic mix of instruments made from conventional instruments altered in highly improbable and imaginative ways, and machine-like found-objects constructions, enhanced by projected visual images.

NEW MUSIC AMERICA 1986 (a review of the music festival of the same name) emphasizes performances involving special sound constructions, with space devoted to Jim Pomeroy, Gordon Monahan, Susan Rawcliffe, and Michael Waisvisz, all of whom build special things to make music with.

Interval Vol. V #2, Spring 1986 (P.O. Box 8027, San Diego, CA 92102), is titled "A New Look at Keyboards", and features several articles on alternative keyboard layouts.

NOTICES

NEW INSTRUMENTS / NEW MUSIC:
ED TYWONIAK LAST MONTH; RICHARD WATERS NEXT MONTH

The **New Instruments / New Music** concert series continues. In the most recent presentation, Ed Tywoniak demonstrated and performed on the E-mu Emulator. The E-mu is at the vanguard of the new sampling hardware, capable of taking natural sound from any source, recording and storing it in digital form, and playing it back under the control of a keyboard. Fascinating and challenging stuff, in a fine presentation by Tywoniak.

The next concert in the series will be presented by Richard Waters, whose work is featured in this issue of **EMI**. Richard's will be a solo performance featuring his Waterphones, accompanied by slides.

The concerts take place at 3016 25th St., San Francisco, 94110, at 2:00 pm on the first Sunday of odd numbered months. For the Richard Waters concert, that's November 2nd. Admission is $5. For more information call (415) 282-1562.

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Jeff Bartone produced the **Sounds Views** project, a series of explorations of sonic art, sound installations and the like, recently broadcast over KAOS-fm radio in Olympia, Washington. Over 40 artists contributed to the project. Bartone is now editing a tape compilation of works featured in the series, and is considering editing a book on the subject. He is interested in hearing from artists working in this area, and writers with something to say on the subject. Contact him at Olympia Media Exchange, TESC CAB-305, Olympia, WA 98505.

PASIC '86, the annual convention of the Percussive Arts Society, will take place in Washington, DC, November 3-8. The address for PAS is 214 W Main St., Urbana, IL, 61801.

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